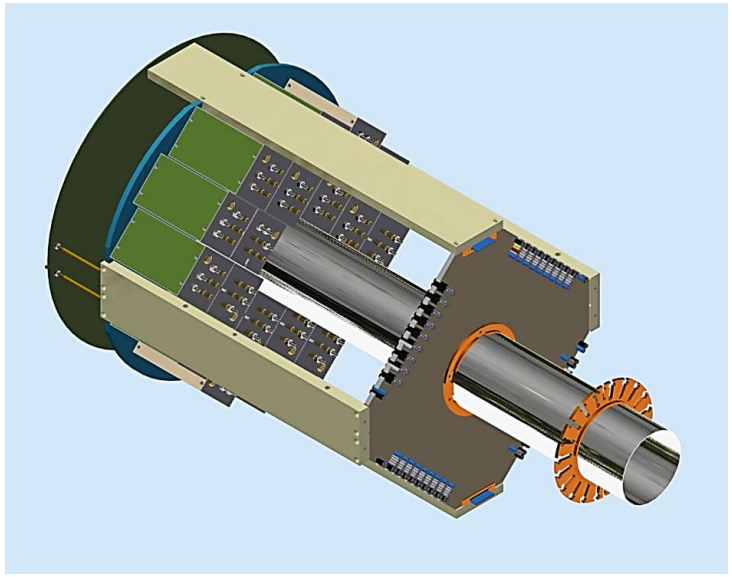
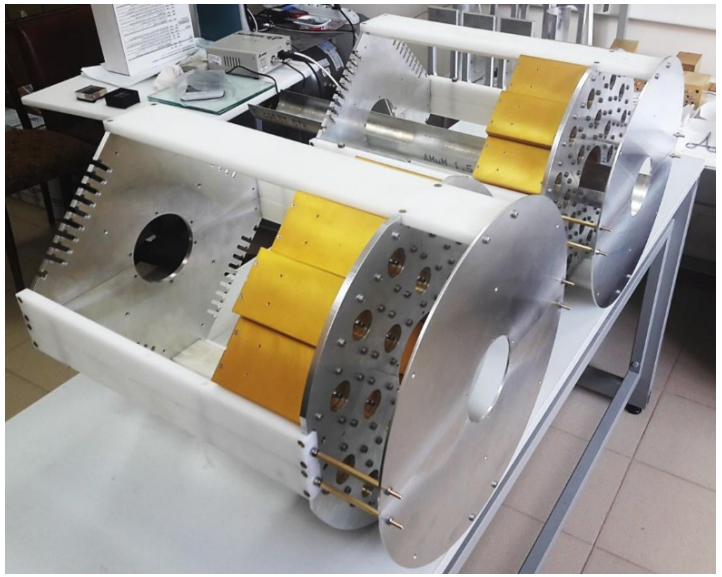
Status of the Fast Forward Detector

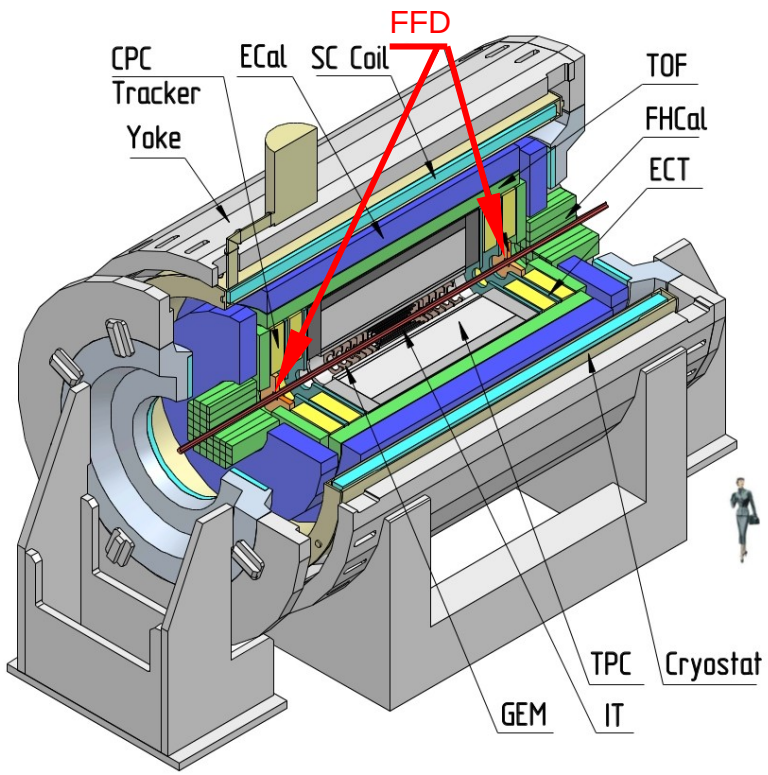
Sergey Sedykh for the FFD group
LHEP / JINR





XIV-th MPD Collaboration Meeting October 14, 2024

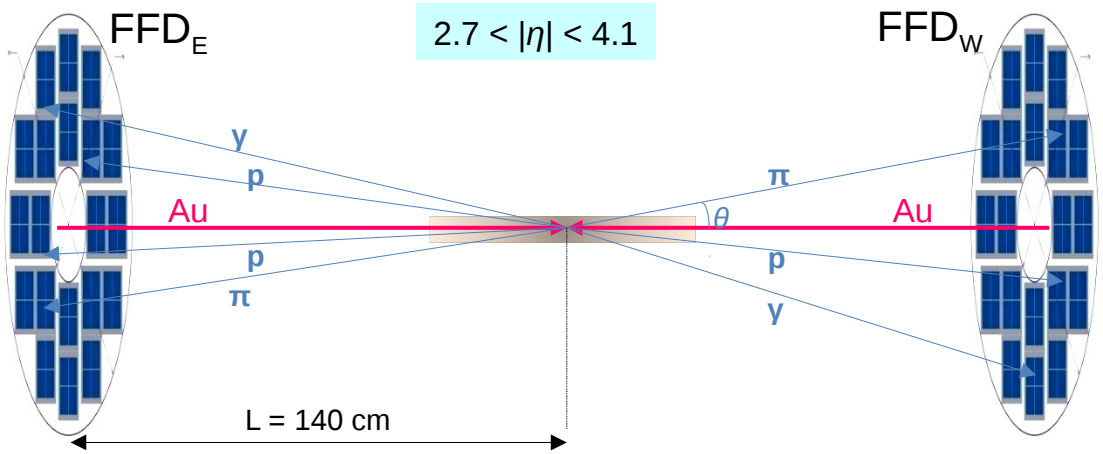
FFD concept and requirements



FFD is one of the trigger subsystems.

FHCal is also expected to be integrated
in the trigger (slower but with larger acceptance).

TOF can also be considered.



Fast interaction trigger & T0 detector for TOF

Trigger is based on coincidence of signals in two sub-detectors

t_E-t_W => localization of interaction point ΔZ < 3 cm

Condition on multiplicity of hits in each arm (80 cells in each arm)

Offline t_0 time for TOF better than 50 ps

FFD team:

Vladimir Yurevich – leader of the FFD project

Sergey Sergeev – electronics and Detector Control System
Viktor Rogov – electronics and cables
Pavel Grigoriev – electronics and software

Vladimir Tikhomirov – mechanics, integration in MPD, cooling
Vitaliy Azorskiy – mechanics
Aleksander Timoshenko – mechanics

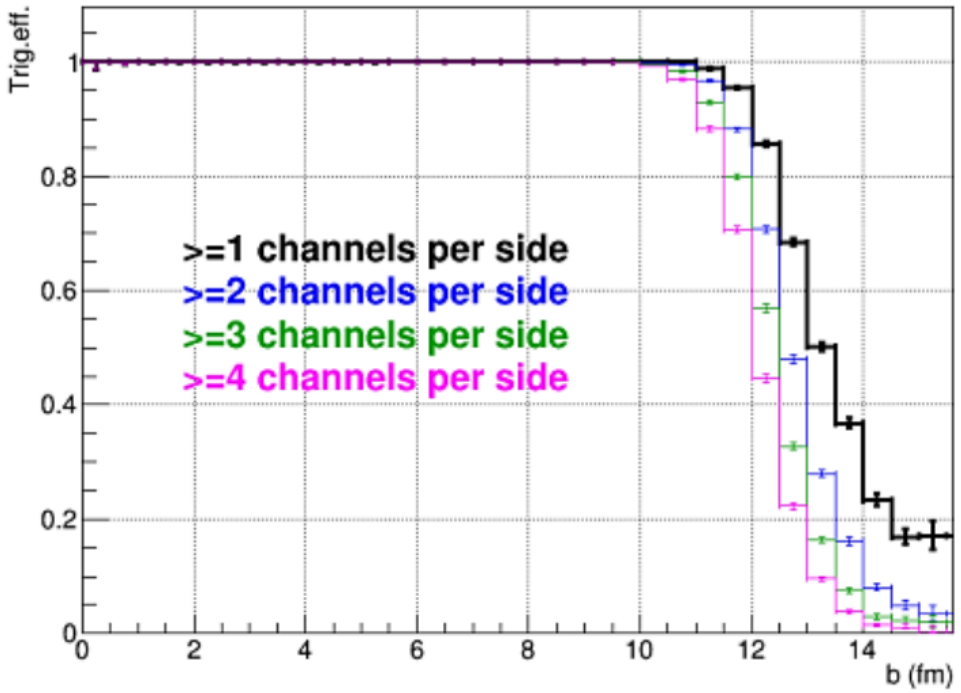
Sergey Sedykh – tests and study of the FFD performance

Nikita Lashmanov – tests and study of the FFD performance,
FFD implementation in MpdRoot

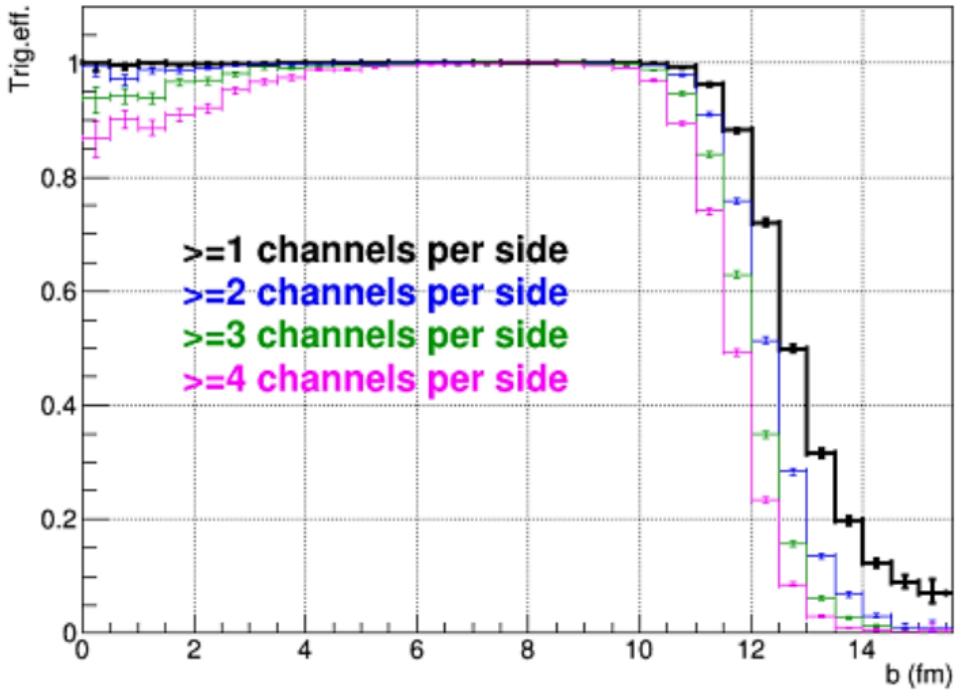
Expected trigger efficiency

V.Riabov
DCM-QGSM-SMM

Au + Au √s = 11 GeV



Au + Au √s = 5 GeV



- Efficiency is ~ 100% in central and semi-central collisions
- " at least one-channel per side" is a preferred option for FFD triggering

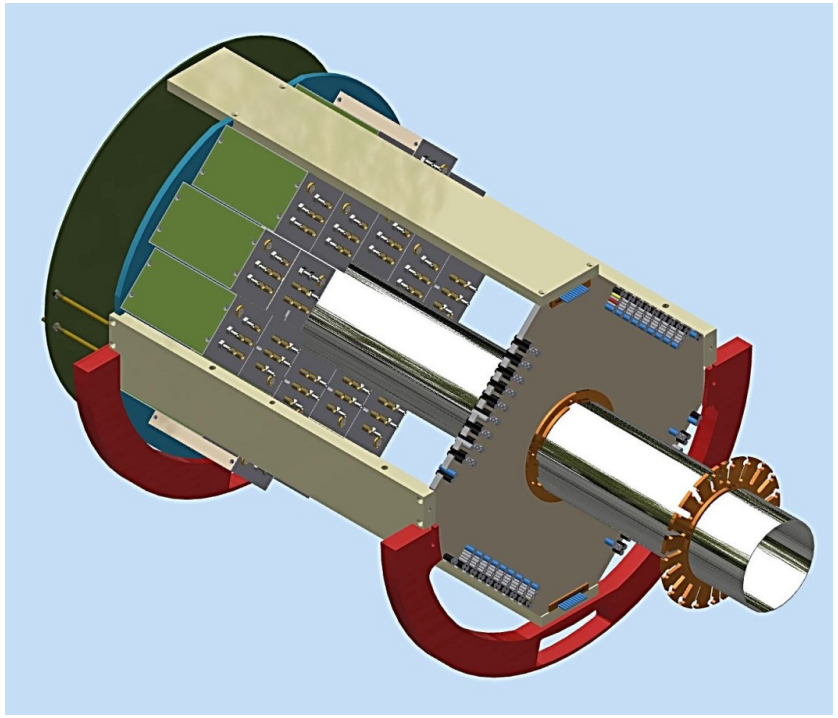
More simulation results in:

Riabov V:	Fixed target trigger efficiency,	Cross-PWG 2023-02-22, 2023-05-30, 2023-11-28, 2024-07-09
	Light collision systems,	Cross-PWG 2023-07-25
	Trigger mass productions,	Cross-PWG 2023-06-24
	PHQMD trigger efficiency,	Cross-PWG 2022-09-06
Ivanishev D:	Trigger studies in the collider mode,	Cross-PWG 2023-08-22

In the fixed target mode
FFD trigger is also important

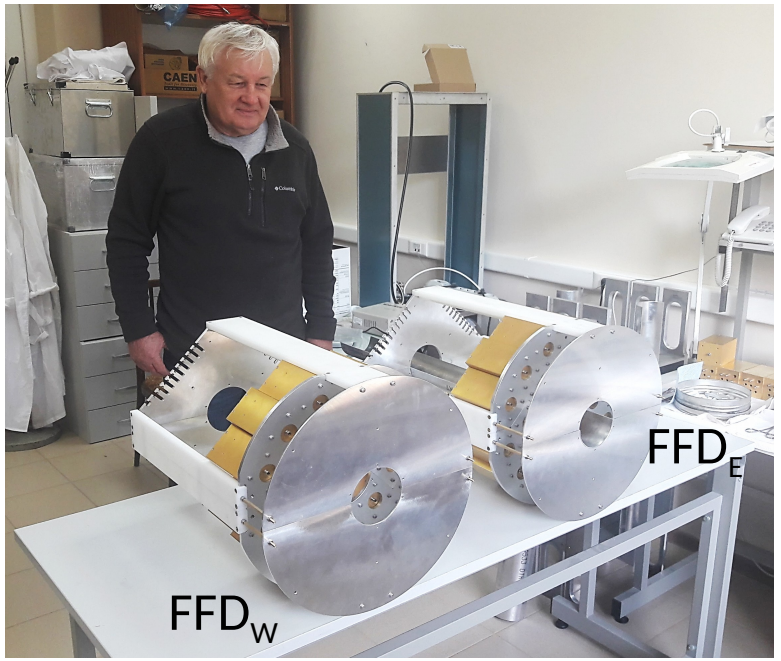
FFD Mechanics

Vladimir Tikhomirov



Design of FFD sub-detector

Tools for FFD installation

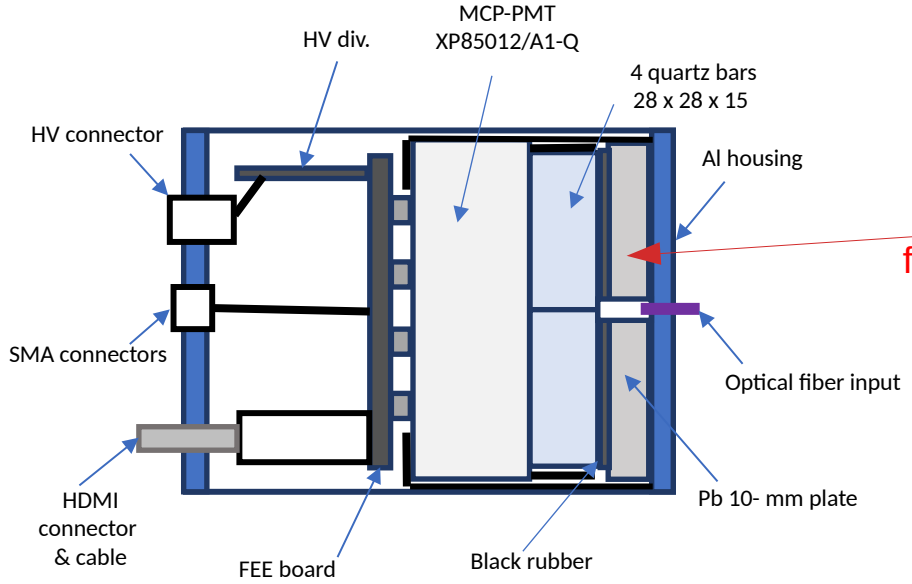


Sub-detector mechanics and integration tools are been used in the MPD integration work with FFD module weight represented by dummies

Current status: All mechanics is ready for installation in the MPD

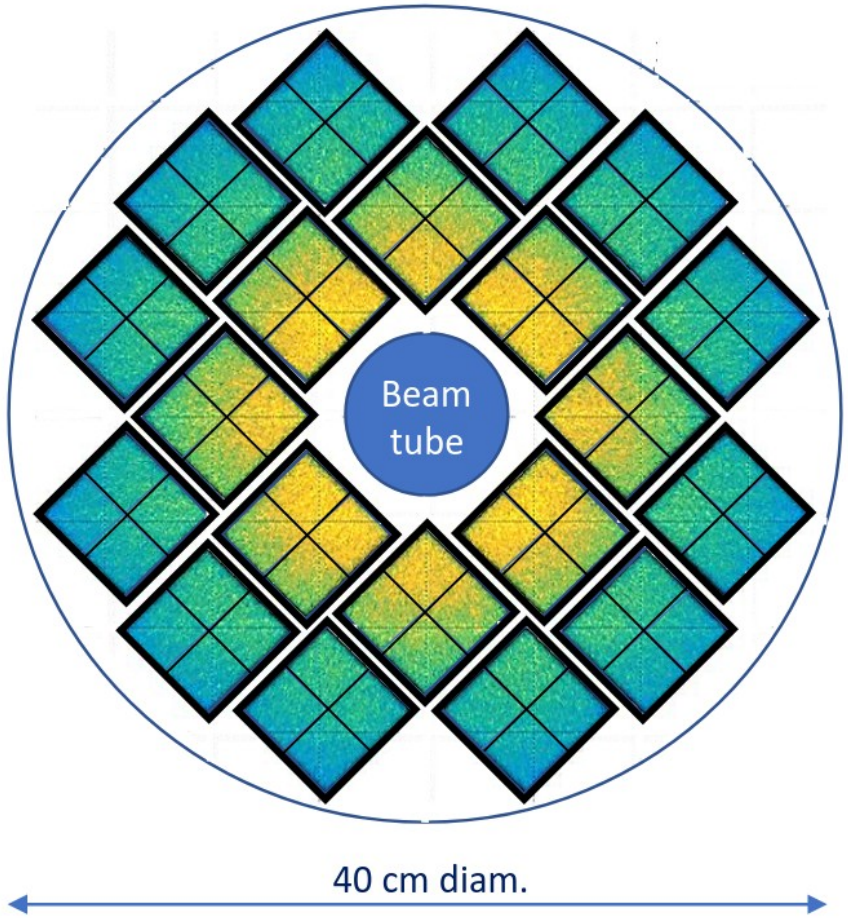
FFD Modules

Viktor Rogov
Vladimir Yurevich

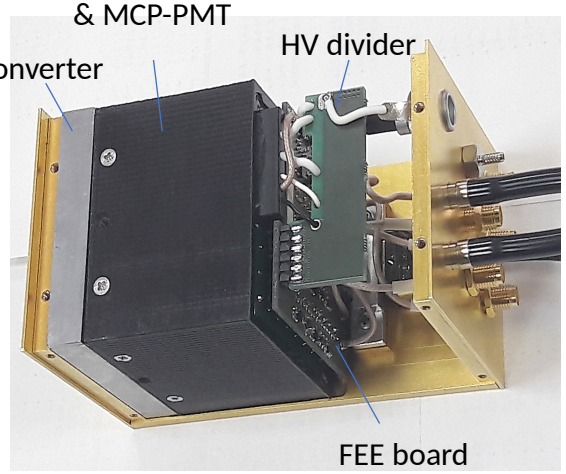


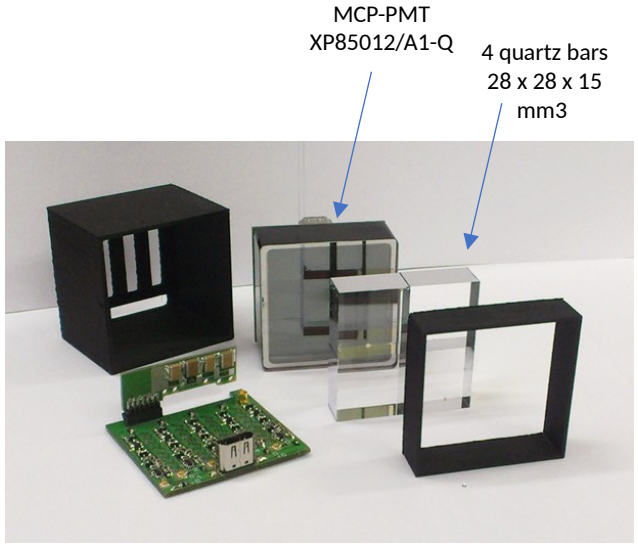
Quartz 56 x 56 mm^2
Module 64 x 64 mm^2
Occupancy 76.6%

80 cells in 20 FFD modules



Box with quartz radiator
& MCP-PMT

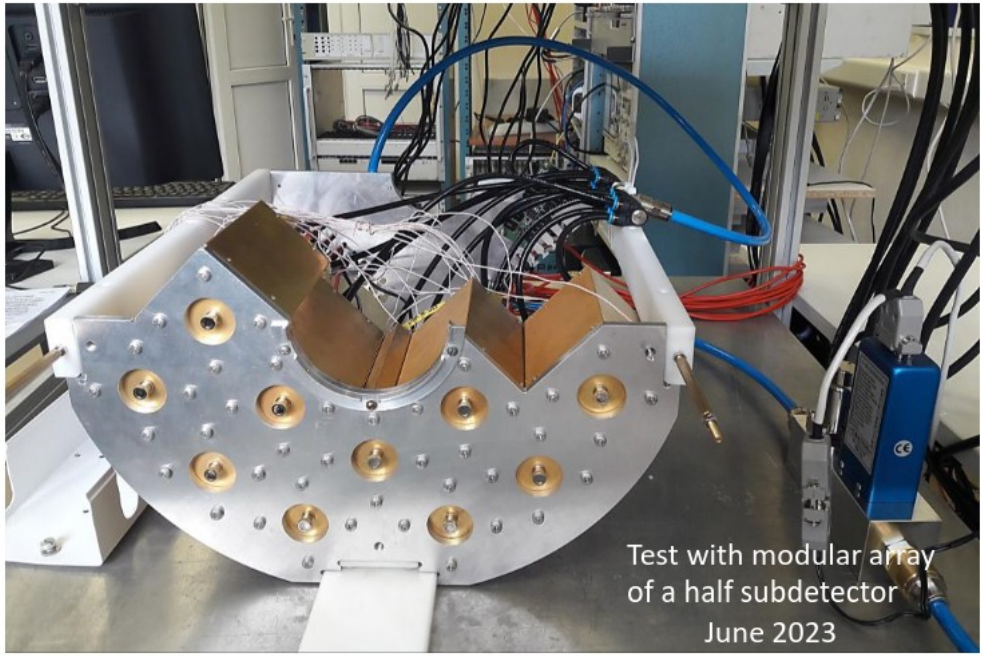




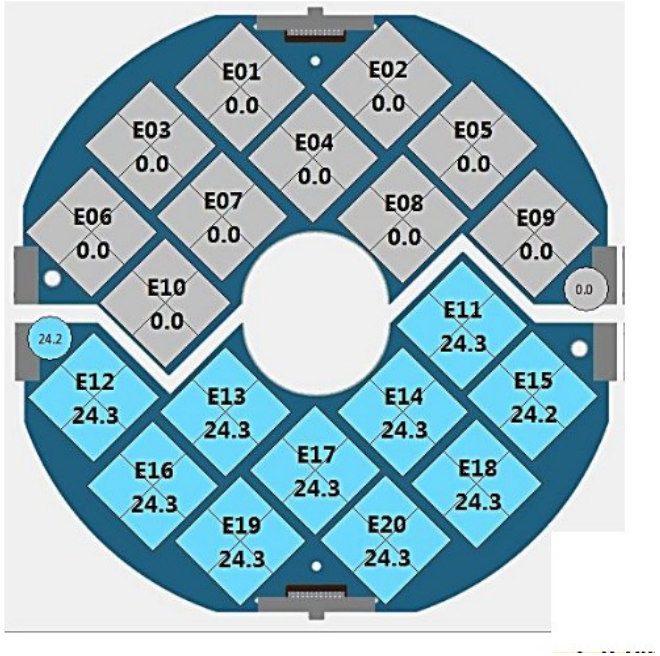
Status:
All 2 x 20 FFD modules are produced and tested

FFD cooling system

Vladimir Tikhomirov
Sergey Sergeev



Interface for temperature monitoring



Status:

all components are available,

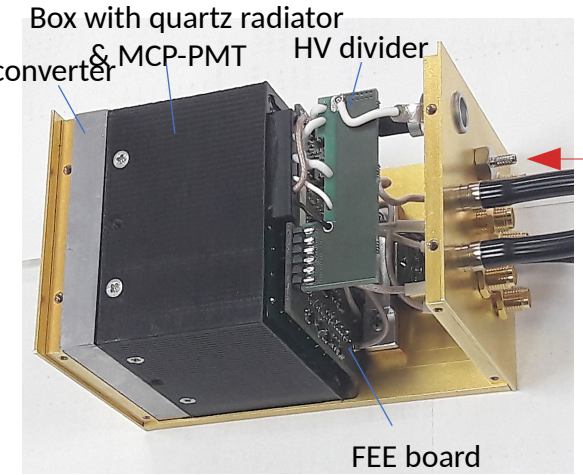
hardware and interface were tested

Temperature inside modules

No air flow	Air flow 40 l/min
+8° C	+4° C

Air of room temperature was used in the tests

We expect that during MPD operation a flow of cool and dry air (nitrogen) will be used.



feed for temperature sensor

gas feedthrough

Laser system

Laser system components

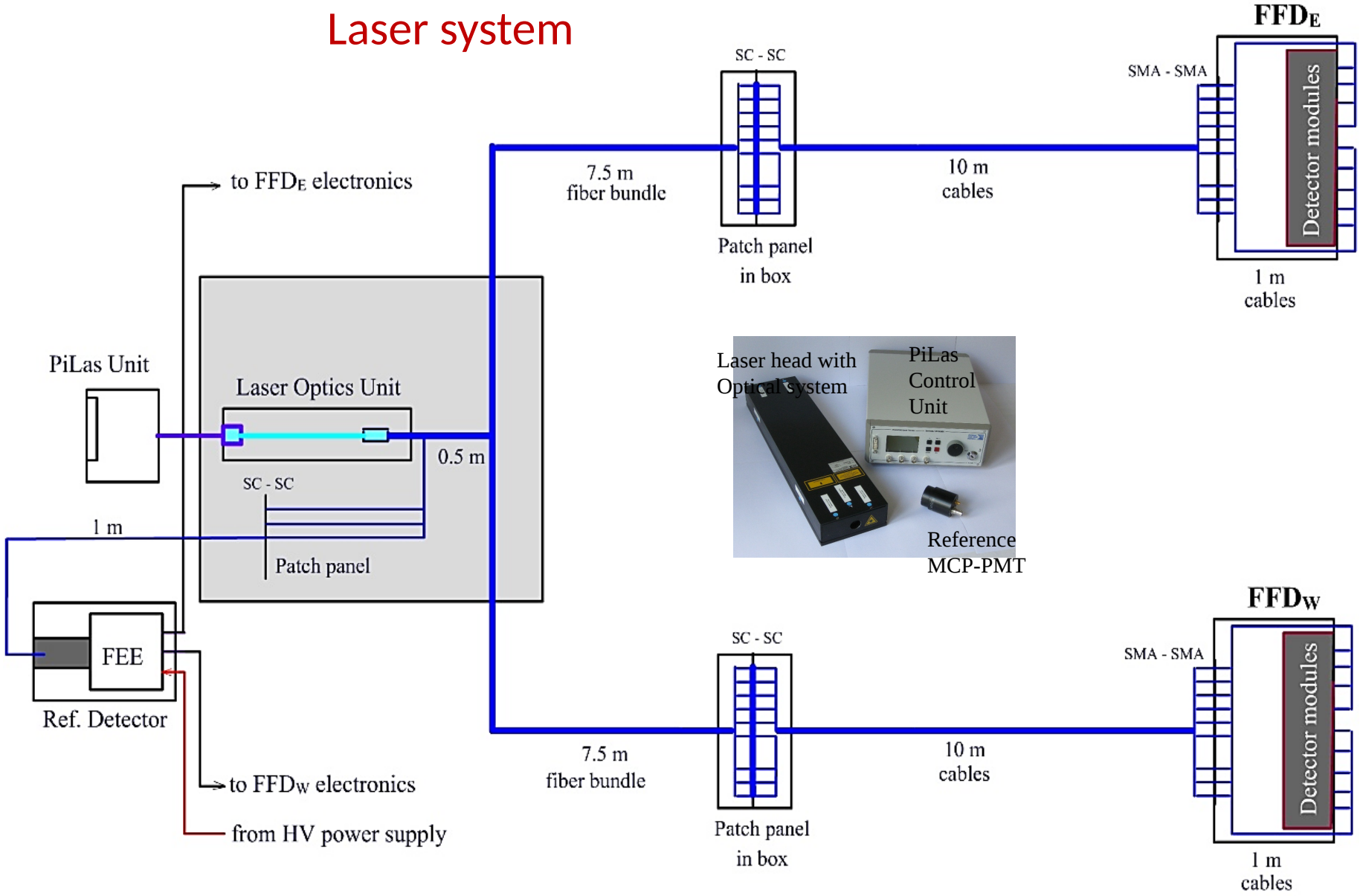
PiLas laser
407 nm, 100Hz - 1MHz,
FWHM 26ps

Reference Detector
MCP-PMT with <30 ps time resolution

Fiber bundles
7.5 m (2 x 60 fibers)

Fiber patch panels

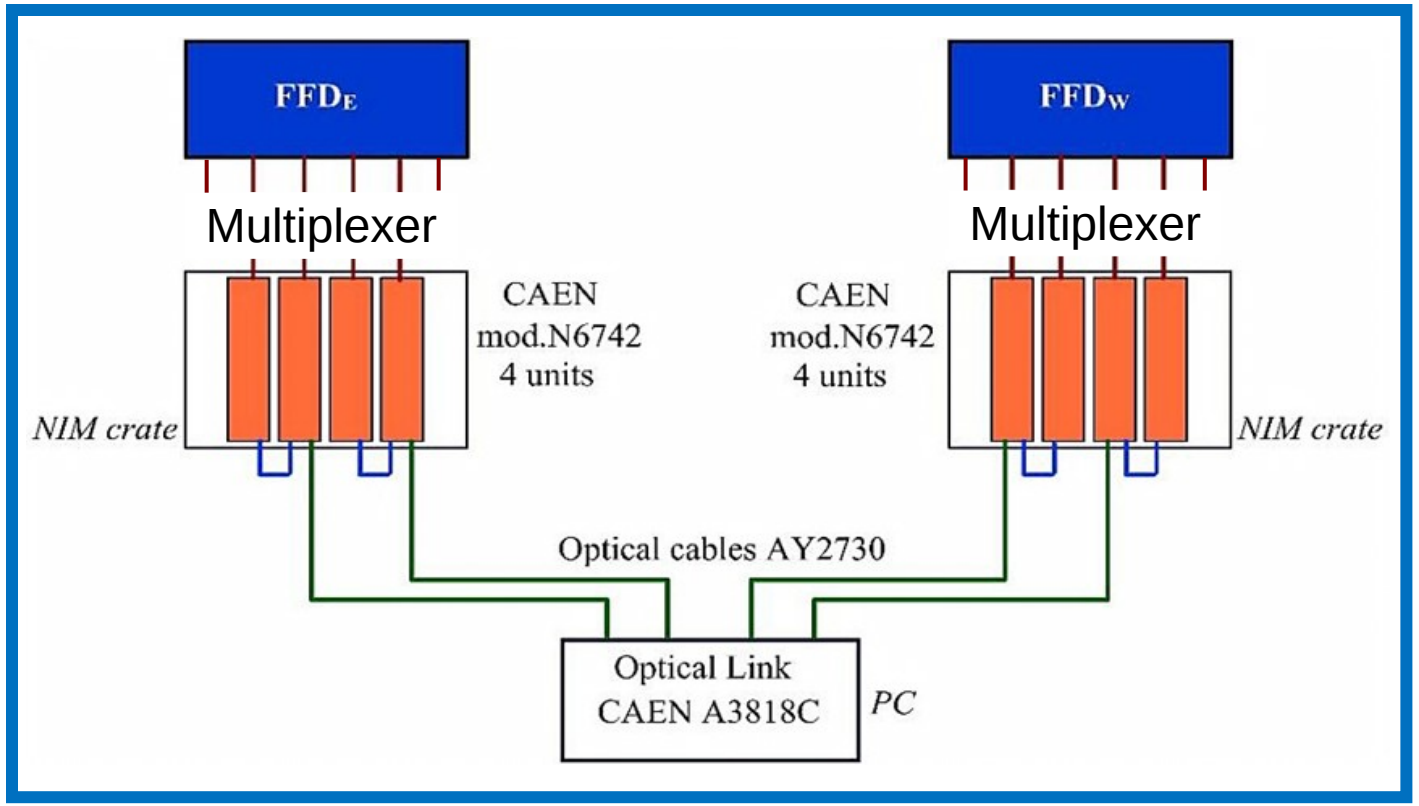
Set of fibers
10 m (2 x 20 pcs.)
1.5 m (2 x 20 pcs.)



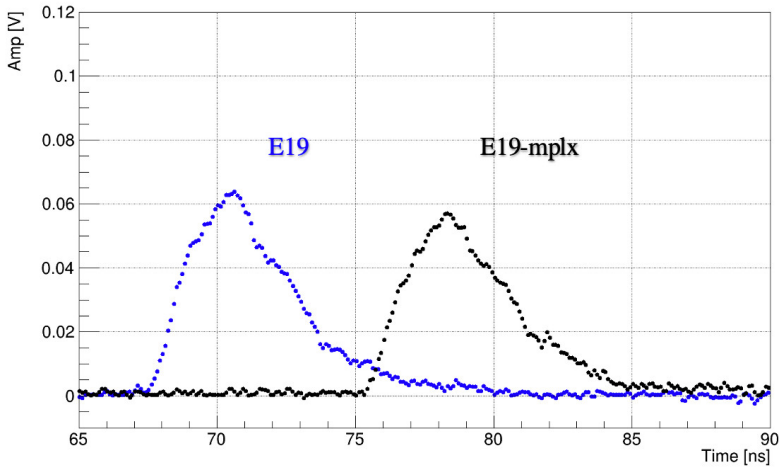
Status:
all components are available, checked
and being used for testing modules and electronics

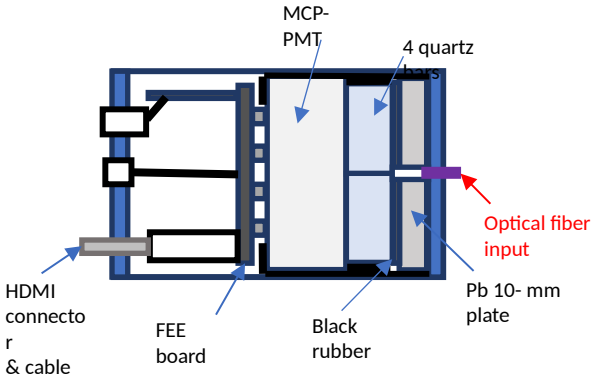
Readout electronics for detector control and calibration

Sergey Sedykh
Nikita Lashmanov



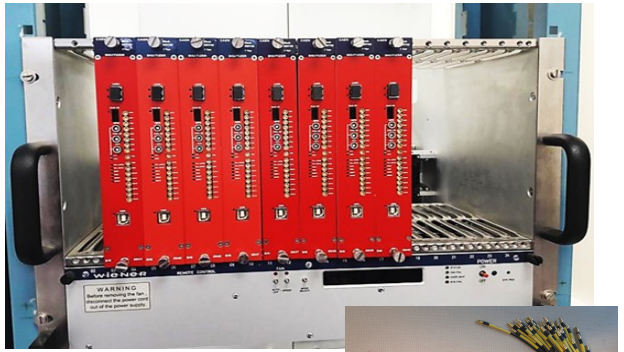
Test of multiplexer with laser system and 1GHz LeCroy Waverunner 9104





Current status:
- all parts are available
- multiplexers 4→1 tested

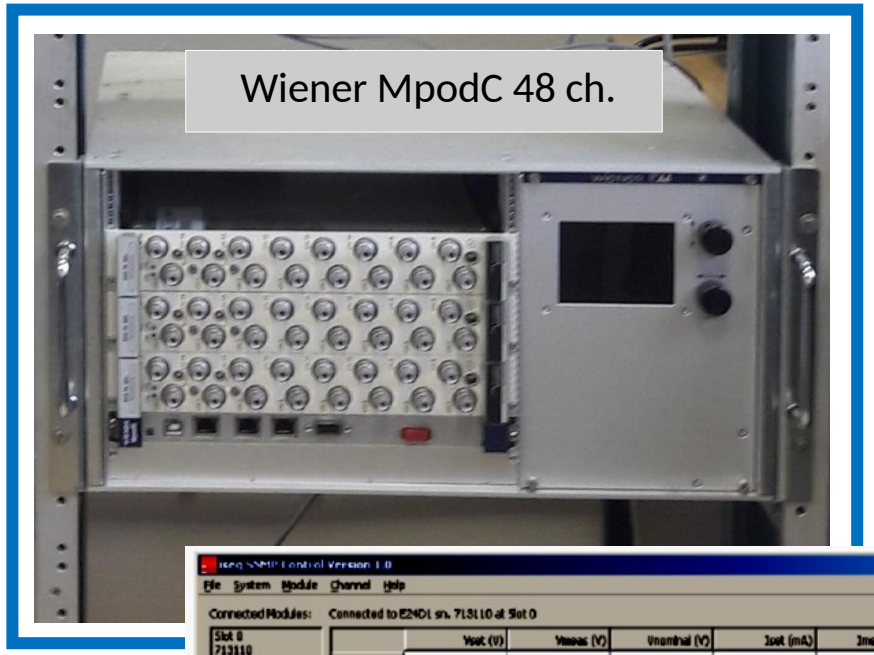
Not ready:
- chain readout of several CAEN N6742
- customized interface

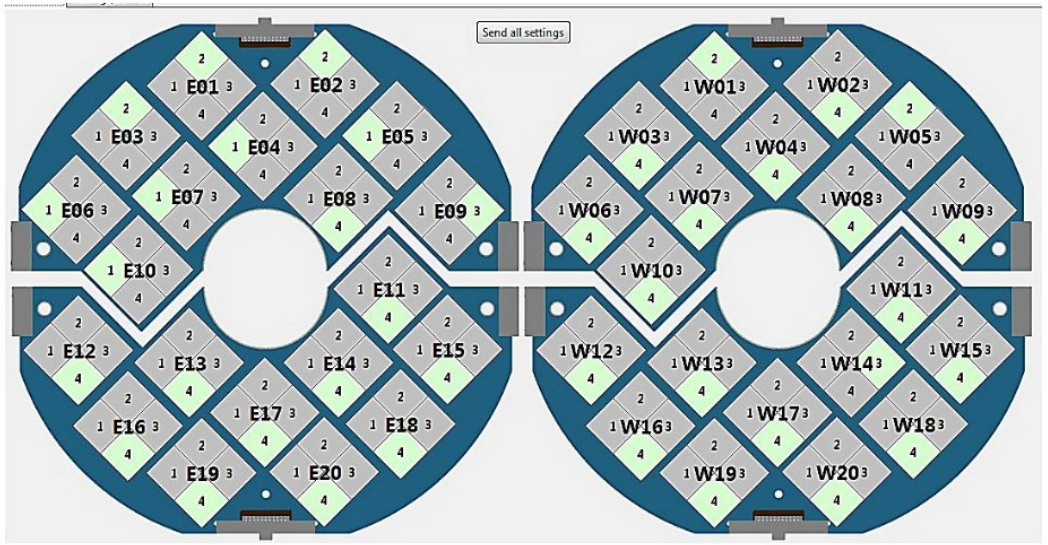


CAEN N6742 and cables

High voltage system

Sergey Sergeev





High voltage interface

Current status:

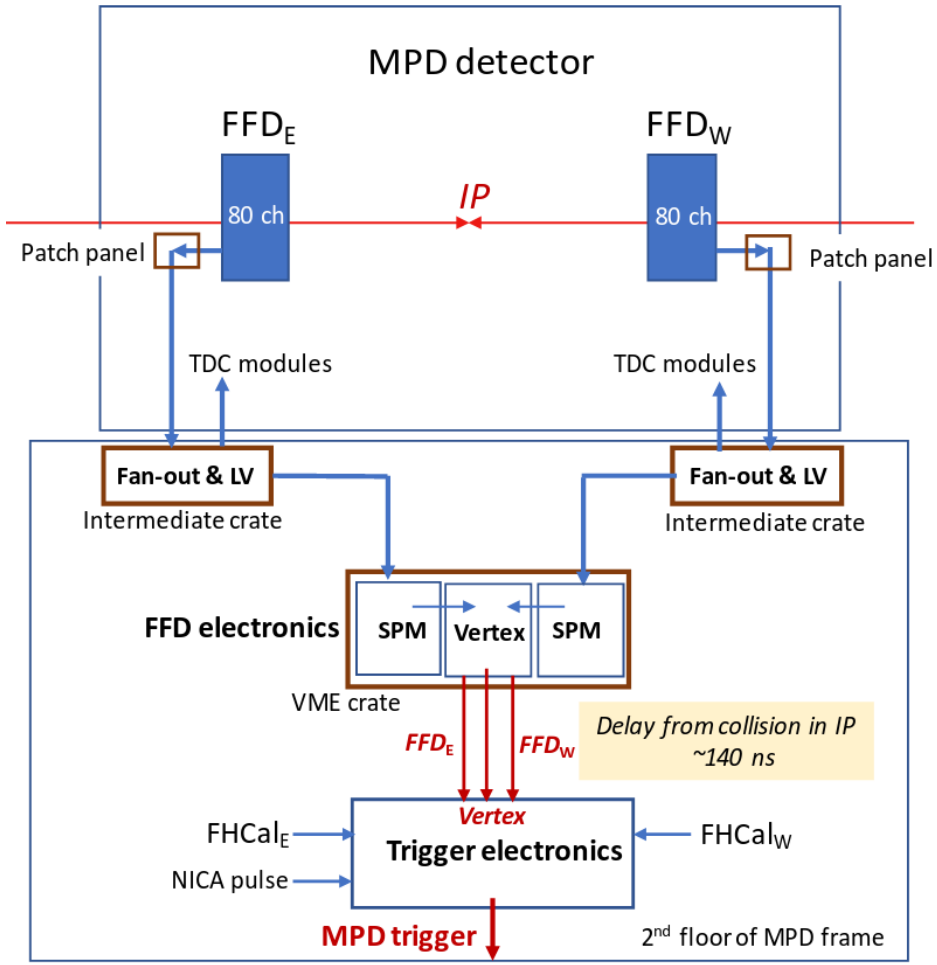
ready and tested,

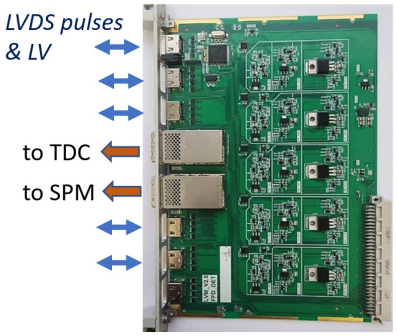
will be used in the long-term tests of sets of modules;

Not yet tested: auto switch-off in the alarm state

Read-out and trigger electronics

Sergey Sergeev
Victor Rogov
Pavel Grigoriev





Fan-out & L V Module

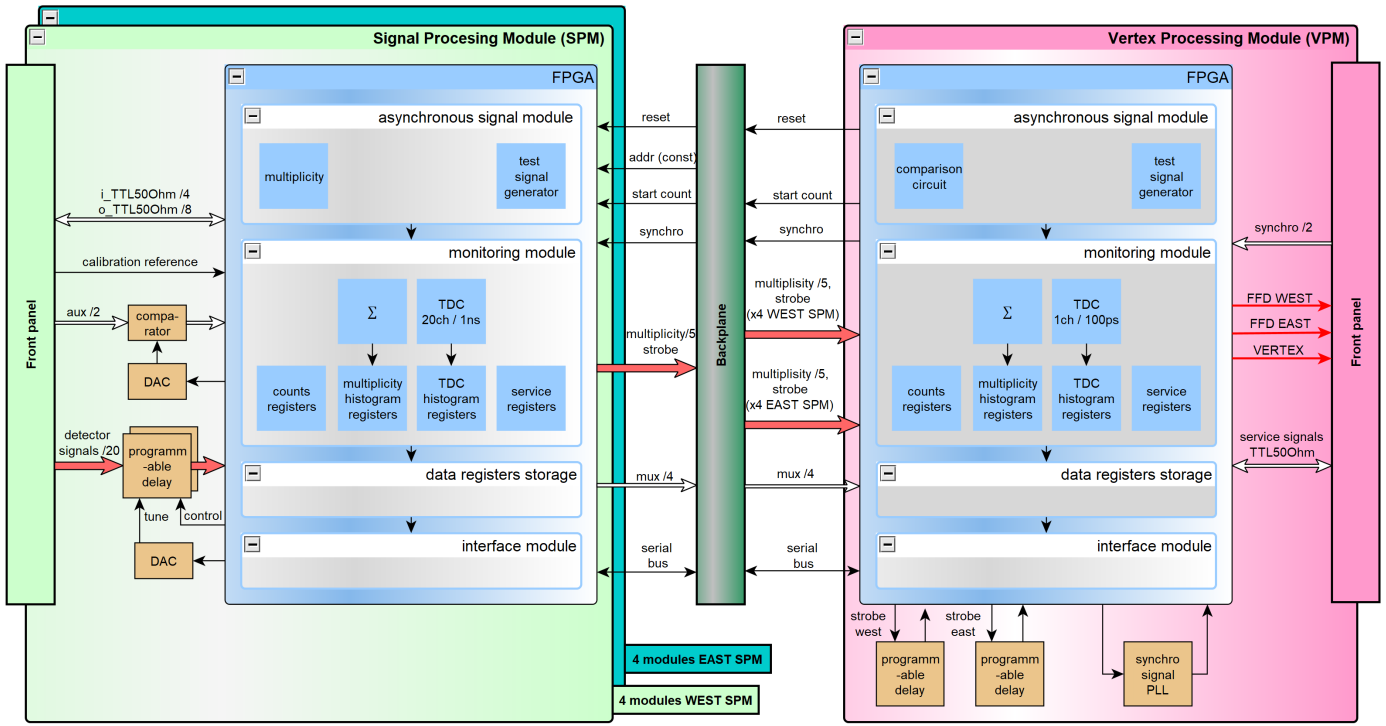
Current status:

TDC: 10 modules TDC72VHL, ready (DAQ group)

Fan-out & LV: ready (Dec.2023 – Jan.2024)

SPM (Signal Processing Module): ready for testing

VPM (Vertex Processing Module): design in progress, all parts available



Current status of electronics and software

Sergey Sergeev

Ready:

LV power supplies hardware and control software (client/server + DIM*)

HV power supply control software (client/server + DIM)

Analog multiplexer and control software

Laser control system software (client/server + DIM)

Temperature monitoring system hardware and control software (client/server + DIM)

Cooling system control software (client/server + DIM)

Signal Processors having facilities as follows (already developed and tested at test-benches)

- command processor
- channel delay setting algorithm
- FPGA-based TDC and histogramming firmware to monitor input signals width
- "fired" channels multiplicity calculation

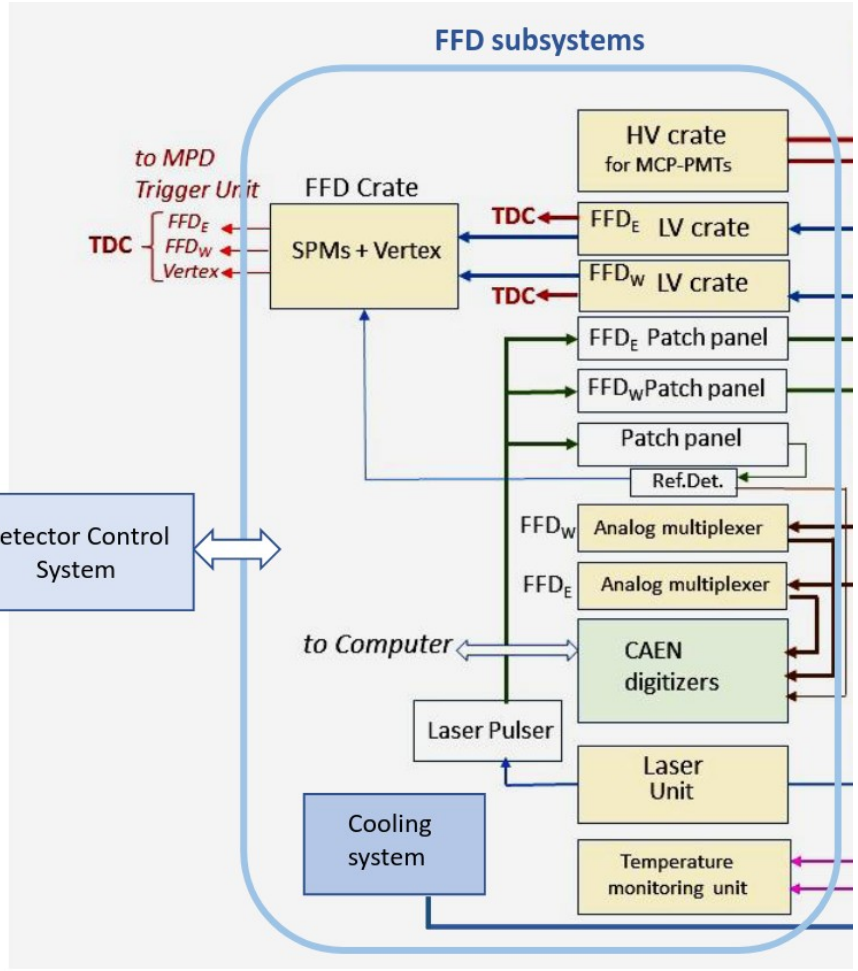
To be done:

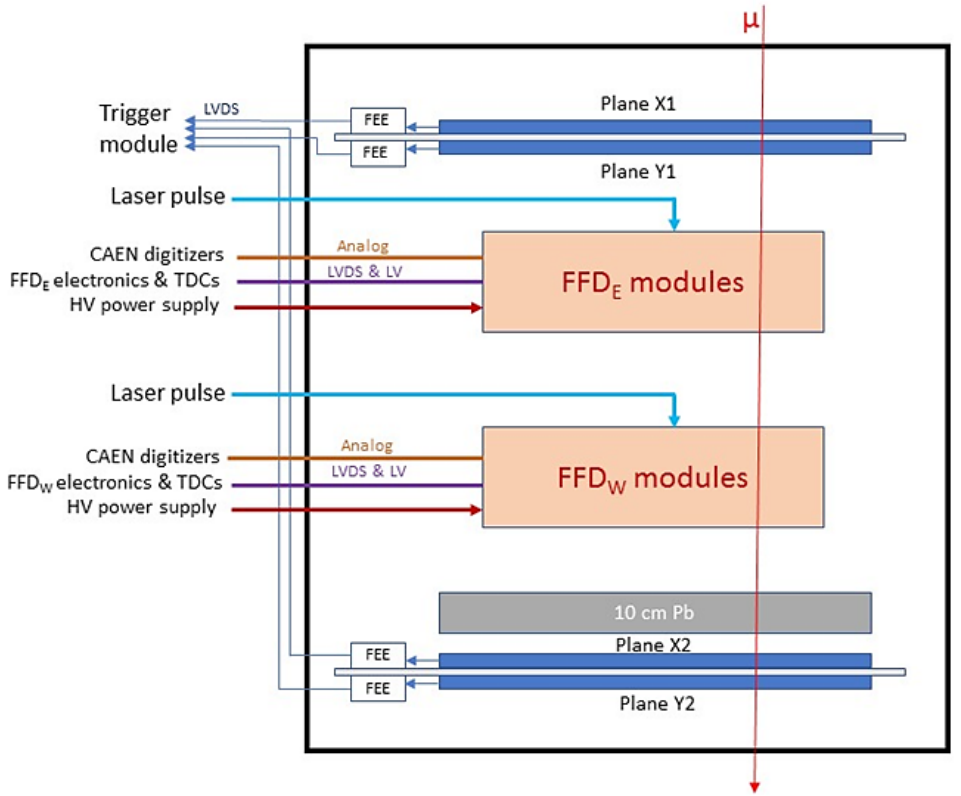
Development of a software for Signal Processors adjustment and monitoring including channel delay alignment with real FFD modules

Connecting the FFD DCS to the MPD CDCS

** DIM – Distributed Information Manager (CERN)*

Long-term tests of the complete FFD system with laser and cosmic stand





Cosmic stand:

Each cosmic stand plane
is 50 × 50 × 1 cm^3
and consists of 10 scintillator strips

The scintillation light is detected
by two SiPMs placed on strip ends

Signals are read-out by TDC72VHL

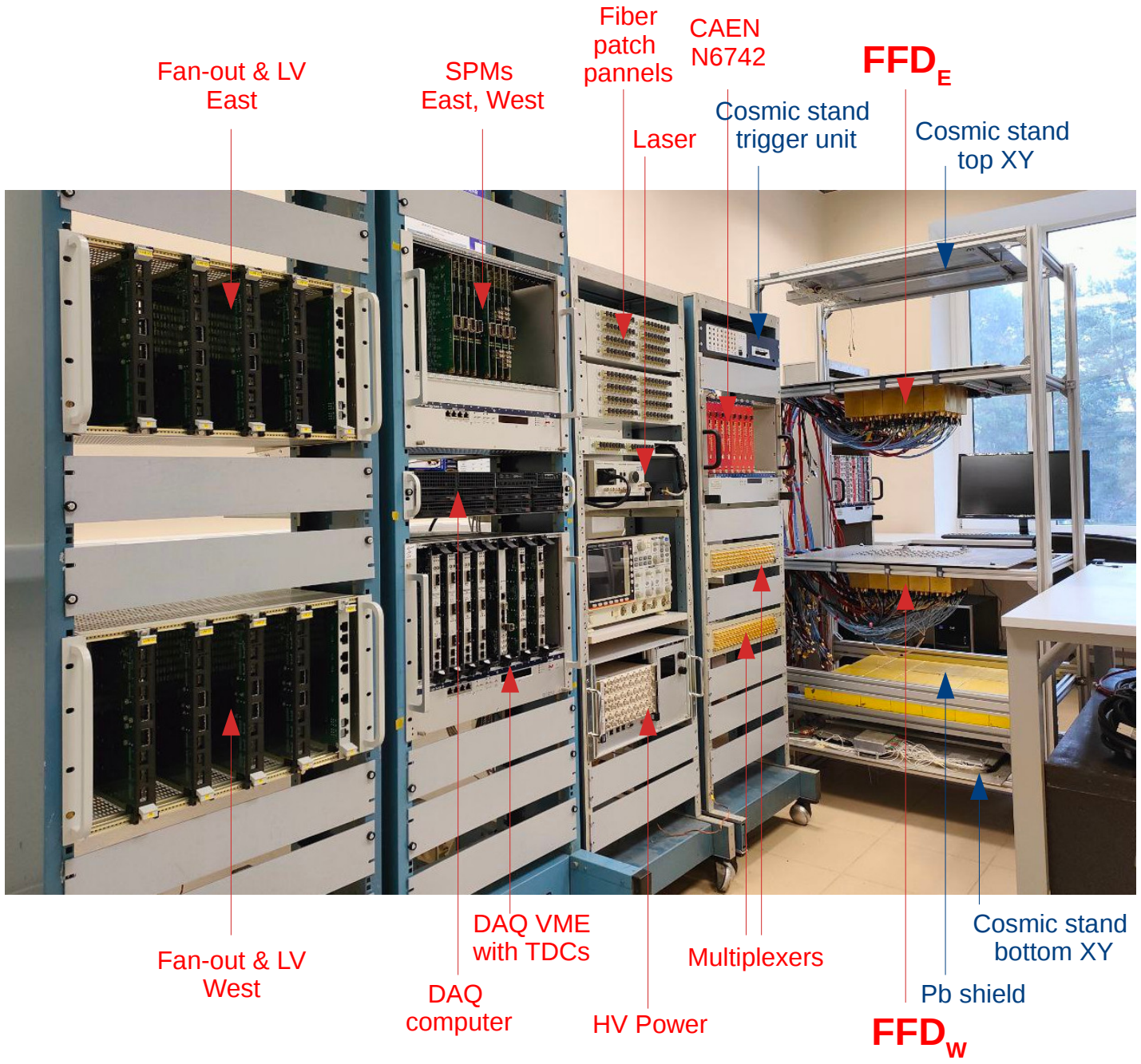
Trigger module:
FPGA Altera Cyclon V

Planned Tests for 2025:

Combined time resolution by group of modules

Laser vs cosmic muons pulse height

Test of full chain of readout and trigger electronics



Full FFD system test preparation

status and plans

Hardware setup: close to completion

Cables: reserved spare space in racks
parts for support (exp. Oct. 2024)

Cabling: planned for Oct.-Nov. 2024

First tests: Nov.-Dec. 2024

Long-term tests: starting Jan. 2025

Summary

Subsystem	Readiness	Plans
Subdetectors (mechanics, modules)	ready	
Electronics	ready (except Vertex module)	Final tuning, tests 11.2024 – 05.2025 VPM exp. ~6 month
HV & LV systems	ready	
Laser system	ready (except full readout)	CAEN readout interface, ~6 month
Cooling system	ready	
DCS & Interface	in progress, most sections are ready	Ongoing, will continue in 2025
Cable system	ready	
Full system test with laser and cosmic muons	in preparation	First tests Nov.-Dec.2024

Thank you for your attention